

**REMARKS**

In order to address the Examiner's rejection of Claims 7, 9 and 10 under 35 USC 112, second paragraph, Claim 9 has been amended to delete the "means" clauses therefrom. Additionally, Claim 9 has been amended to state that the electrolytic gas generation device consists essentially of the listed elements. No new matter has been added.

Claims 7, 9 and 10 have been rejected under 35 USC 103(a) as being unpatentable over Yamanaka et al in view of Uchida et al. Applicants respectfully traverse this ground of rejection and urge reconsideration in light of the following comments.

The presently claimed invention is directed to an electrolytic gas generation device for generating ozone gas which consists essentially of an anode chamber in which the ozone gas and oxygen is generated, a cathode chamber in which hydrogen gas is generated, a solid electrolyte ion exchange film separating the anode chamber from the cathode chamber, a porous anode provided at a first side of the ion exchange film in the anode chamber, a porous cathode provided at an opposite side of the ion exchange film in the cathode chamber, a power source for imposing a potential difference between the porous anode and the porous cathode, a pure water supply source for supplying pure water to a mixer, a carbon dioxide supply source for supplying carbon dioxide to the mixer and a mixer for mixing the pure water and carbon dioxide to form carbonated water and supplying the carbonated water to the anode chamber.

As explained in the previous Response, the instant invention is based on the discovery that when pure water is mixed with carbon dioxide and used as an anolyte in an electrolytic gas generation device for generating ozone gas, high concentration ozone can be produced continuously and stably over an extended period of time. In conventional processes in which ultrapure water is used and not mixed with

carbon dioxide, the generation efficiency of the ozone gas is only about 10%, which is about 1/3 of the efficiency obtained by the present invention. It is respectfully submitted that the prior art cited by the Examiner does not disclose the presently claimed invention.

The Yamanaka et al reference discloses a high-purity water producing equipment comprising an electrolytic unit for producing anolyte electrolytic ionized water. The ultrapure water-generating device of Yamanaka et al allows the sterilization of the pure water and the cleaning thereof by eliminating fine particles with an electrolyte added to the supply water fed into an electrolytic bath installed in-line in an ultrapure water-generating apparatus or to the electrolytic water after hydrolysis to be realized more efficiently. The electrolytic apparatus 300 shown in Figures 11-13 of this reference contains a means 351 for supplying an electrolyte such as an acid or alkali into the supply pipe 10111 to the anode chamber 321 and a means 352 for supplying an electrolyte such as an acid or alkali into the supply pipe 10113 to the cathode chamber 323 for processing of the primary pure water fed into the electrolytic apparatus.

The presently claimed invention is distinguishable over the electrolysis cell of Yamanaka et al in that the present invention has only two chambers and ozone is basically generated at a high concentration consistently and continuously for an extended period of time while carbonic water, which is a mixture of pure water and carbon dioxide, is fed into the anode electrode chamber where the ultrapure water is electrolyzed. The "consisting essentially of" language now present in the instant claims eliminates the three chamber configuration disclosed in Yamanaka et al. The device in Yamanaka et al sterilizes water with an electrolyte such as an acid or an alkali added thereto while the device of the present invention produces ozone at a high concentration consistently and continuously for an extended period of time.


It is respectfully submitted that the presently claimed invention is patentably distinguishable over Yamanaka et al.

Uchida et al was cited by the Examiner for its disclosure of a carbonation device and, from this, the Examiner posits that it would be obvious to add the carbonation device of Uchida et al to the electrolytic cell of Yamanaka et al. However, there is nothing in this reference which would suggest the modification of the cell structure of Yamanaka et al from a three chamber electrolytic device to a two chamber cell as required by the currently presented claims. Therefore, Applicants respectfully submit that the presently claimed invention is clearly patentably distinguishable over the references cited by the Examiner.

In order to illustrate the distinctions between the presently claimed invention and the prior art, Applicants are enclosing herewith an article regarding the production of active electrolytic water that shows the distinctions between chlorine-based oxidative water and ozone-based oxidative water.

The Examiner is respectfully requested to reconsider the present application and to pass it to issue.

Respectfully submitted,

  
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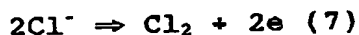


Active electrolytic water: strongly oxidative water and strongly reductive water

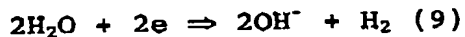
A method of producing active electrolytic water by electrolysis of the mixture of tap water and for example sodium chloride was developed around 1990 mainly by Dr. Noriaki Matsuura in Miura Denshi Co., Ltd. and elsewhere<sup>2)</sup>. The positive-electrode electrolytic water, strongly oxidative water (SO water), is used mainly for sterilization and disinfection, while the negative-electrode electrolytic water, strongly reductive water (SR water) found application as ashing water and is already commercialized.

In the case of alkali ion water, the active electrolytic water is generated mainly in the following reactions:

Positive electrode:



Negative electrode:



The active electrolytic water obtained in these reactions has the following water quality characteristics:

SO water: pH < 2.6, ORP > +1000 mV (vs. Ag/AgCl)

RO water: pH > 11, ORP < -800 mV (vs. Ag/AgCl)

The pH of <2.7 of the SO water is caused by the proton ions generated by oxidation decomposition of water on the positive electrode, as shown in Formula (4). The main component responsible for the ORP of >+1000 mV seems to be hypochlorous acid (HClO) generated in Formula (a), although it depends on the pH of the system, and chlorine and oxygen are also responsible to some extent. Because decrease of pH is accompanied by increase of harmful chlorine rate, a SO water at a pH of 3 or more is more desirable when the working environment is considered, as there is almost no difference in sterilization force.

On the other hand, the pH of >11 of the SR water is caused by the hydroxide ions generated in the reductive reaction of water in Formula (9), and the ORP of <-800 mV is based on the hydrogen gas generated. As obvious from the description above, the pH of the SO water and the SR water is relatively stable, while the ORP is more variable, and in particular, the negative ORP of the SR water, which is dependent on the hydrogen gas generated that is less soluble in water and easily released, varies significantly. Therefore, it is possible to preserve the negative electrical potential of the SR water, if the release of hydrogen gas is prevented.

Currently available SO water is mainly chlorine-based SO water that is prepared by addition for example of sodium chloride to tap water. However, because chlorine gives chlorinated organic compounds such as carcinogenic trihalomethane in

reaction with organic compounds, there is a world-wide demand for gradual reduction in the amount of chlorine used.

Hypochlorous acid ( $\text{HClO}$ ), the main component responsible for the ORP of the SO water is more active by approximately 10 times or more than sodium hypochlorite ( $\text{NaClO}$ ) commonly used currently for disinfection and sterilization, and thus, can be used at a concentration of 1/10 or less, which favorably leads to decrease in the environment load, compared to use of  $\text{NaClO}$ . However, the SO water is still a chlorine-based water. Under the circumstance above, there was an increased interest on ozone, especially in the food sector. However, hypochlorous acid water was approved again as a food additive on June 10, 2002 under the condition that the water has a pH of  $<2.7$  and an effective chlorine content of 20 to 60 mg/kg. Although use of the hypochlorous acid water goes against the time, it is still more favorable than use of  $\text{NaClO}$ , at least in that the environment load is smaller as described above. However, for more favorable work environment, the pH of the water was desirably  $\geq 3$ , rather than  $<2.7$ , because there is almost no difference in sterilization force between them.

Table 5.4 shows classification of the SO water. The ozone-based strongly oxidative water shown in Table 5.4 can be prepared in a 3-chamber electrolytic bath shown in Figure 5.5. The semi-ozone-based SO water and the semi-chlorine-based SO water shown in Table 5.4 are similar in properties and prepared in the type-1 electrolytic bath shown in Table 5.5<sup>3)</sup>. The pure ozone-based SO water is a complete ozone-based system, and is

prepared in the type-3 apparatus containing pure water in the intermediate chamber of the three-chamber electrolytic bath shown in Figure 5.5. Similarly, the ozone-based strongly oxidative water is prepared in a type-1S apparatus. Actually, ozone has an oxidative force higher than chlorine. However the solubility thereof in water is smaller than that of chlorine. Therefore, chlorine is more favorable from the point of consistency.

Table 5.4. Classification of strongly oxidative water

Chlorine-based	1) Pure chlorine-based strongly oxidative water 2) Chlorine-based strongly oxidative water 3) Semi-chlorine-based strongly oxidative water
Ozone-based	1) Semi-ozone-based strongly oxidative water 2) Ozone-based strongly oxidative water 3) Pure ozone-based strongly oxidative water

Figure 5.5. Main electrolytic process in type-1 three-chamber electrolytic apparatus

(When NaCl is used)

Cathode chamber

Electrode

Separation membrane

Solid electrolyte

Anode chamber

Thus for the purpose of sterilization or disinfection, the ozone-based water or the semi-ozone-based SO water would be practically more desirable than the pure ozone-based SO water. Use of the three-chamber electrolytic bath enables electrolysis of water at low voltage by using ultrapure water as the raw water without direct addition for example of sodium chloride to the raw water. Since ultrapure water can be electrolyzed, pure water and tap water are of course electrolyzed easily. Common two-chamber and three-chamber electrolytic apparatuses are compared in Table 5.6. The three-chamber electrolytic apparatus, which has an additional intermediate chamber, can give waters having various properties, according to the material added to the intermediate chamber. Typical examples thereof are summarized in Table 5.5.